UNITED STATES MARINE CORPS
Logistics Operations School
Marine Corps Combat Service Support Schools
Training Command
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LVSM 7205

STUDENT OUTLINE

MAINTAIN THE MK48 ENGINE FUEL AND COLD START SYSTEM

LEARNING OBJECTIVE

1. Terminal Learning Objective:

a. Given an MK48, TM 2320-20/12A, tools, and equipment, perform second echelon maintenance on the engine fuel system, per the reference (3521.13.09)

b. Given an MK48, TM 2320-20/12A, tools, and equipment, perform second echelon maintenance on the engine cold start system, per the reference (3521.13.10)

2. Enabling Learning Objectives:

a. Given an LVS, TM 2320-20/12A, tools, and equipment, inspect the fuel system for serviceability, per the reference (3521.13.09a)

b. Given an LVS, TM 2320-20/12A, tools, and equipment, service the fuel system, per the reference (3521.13.09b)

c. Given an LVS, TM 2320-20/12A, tools, and equipment, test the components of the fuel system, per the reference (3521.13.09c)

d. Given an LVS, TM 2320-20/12A and partial statements pertaining to the MK48 fuel system, complete the partial statements to describe the procedures used to diagnose a malfunctioning fuel system, per the reference (3521.13.09d)

e. Given an LVS, TM 2320-20/12A, tools, and equipment, repair components of the fuel system, per the reference (3521.13.09e)

f. Given an LVS, TM 2320-20/12A and partial statements pertaining to the MK48 fuel system, complete the partial statements to describe the procedures

used to replace unserviceable components of the fuel system, per the reference (3521.13.09f)

g. Given an MK48, TM 2320-20/12A, tools, and equipment, inspect the cold start system for serviceability, per the reference (3521.13.10a)

h. Given TM 2320-20/12A and partial statements pertaining to the MK48 engine cold start system, complete the partial statements to describe the procedures used to test components of the cold start system, per the reference (3521.13.10b)

i. Given TM 2320-20/12A and partial statements pertaining to the MK48 engine cold start system, complete the partial statements to describe the procedures used to diagnose a malfunctioning cold start system, per the reference (3521.13.10c)

j. Given TM 2320-20/12A and partial statements pertaining to the MK48 engine cold start system, complete the partial statements to describe the procedures used to repair components of the cold start system, per the reference (3521.13.10d)

k. Given TM 2320-20/12A and partial statements pertaining to the MK48 engine cold start system, complete the partial statements to describe the procedures used to replace unserviceable components of the engine cold start system, per the reference (3521.13.10e)

OUTLINE

1. IDENTIFICATION, LOCATION AND FUNCTION OF THE COMPONENTS EMPLOYED IN THE DETROIT 8V92TA ENGINE FUEL SYSTEM

a. The fuel system of the Detroit 8V92TA diesel engine employs two fuel tanks, a fuel/water separator, hand priming pump, fuel supply pump, filter, shutdown solenoid, throttle control solenoid, and ether starting aid.

(1) The MK48 has two 75 gallon fuel tanks. One tank is mounted on each fender, above the No. 2 axle. The fuel level sending unit is located in the right fuel tank. A fuel shutoff valve, which is used to close the fuel flow between the two tanks, is located at the rear of each fuel tank.

(2) The fuel/water separator, which is actually the primary filter, is located at the rear of the right fuel tank and is a three-stage device used to separate water from the fuel and filter out solid particles.

(a) In the first stage, liquid and solid contamination as small as 30 microns are separated by a swirling action created as fuel passes

through a turbine centrifuge. Water and large particles sink to the bottom of the fuel bowl because they are heavier than fuel. The contaminants will remain there until the bowl is drained.

(b) In the second stage, any water still in the system condenses on the separator shell. When droplets form, their weight causes them to fall to the bottom of the fuel bowl.

(c) In the third stage, a replaceable filter element traps solid particles of dirt that still remain in the fuel.

(d) Incorporated into the fuel/water separator is a disk-type fuel heater which is a cold weather starting aid. An internal automatic thermostat will turn the heater on when the fuel temperature is below 45 degrees Fahrenheit. The heater is located just below the replaceable filter element. Its purpose is to melt the wax crystals and allow fuel to pass through the filter easier. The heater can also be operated without the engine running by turning the engine start switch to the "ON" position for at least 5 minutes.

(3) The hand priming pump is a piston-type pump located at the rear of the right fuel tank and to the right of the fuel/water separator. The hand priming pump is used to prime the fuel system when air has entered into the system.

(4) The fuel supply pump, which was also discussed in your class on the vehicle engine, is the heart of the fuel system. It is a positive displacement, gear-type pump that draws the fuel from the fuel tanks and transfers the fuel to the fuel injectors.

(a) The fuel pump is attached to the governor housing at the top of the engine, near the front.

(b) The fuel pump is driven by the right-hand blower rotor by means of a drive coupling fork. The fuel pump does not need to be timed to the engine because all injection timing is accomplished through the injector rocker arms and the injectors.

(5) The secondary fuel filter is a replaceable filter that traps extremely fine particles that have passed through the fuel/water separator. The secondary filter is a spin-on type filter and is located at the rear of the right fuel tank and to the left of the fuel/water separator.

(6) Drilled passages within the cylinder head route fuel to and from the injectors. The fuel pipes provide a bridge for the fuel to flow from the cylinder head manifolds to the injectors and back again.

(7) Injector Control Tubes

(a) The two fuel injector control tube assemblies are mounted on the left and right bank cylinder heads of the engine. Each tube assembly consists of a control tube, injector rack control levers, a return spring, and injector control tube lever mounted in two bracket and bearing assemblies.

(b) The control tubes are connected to the injector control racks and the governor. The control tubes keep the injectors balanced together and provide the mechanical means for injecting the right amount of fuel to run the engine under varying loads and speeds.

(8) This engine features a double-weight, variable-speed, mechanical governor. The governor is mounted on and driven by the blower. The governor has two functions.

(a) It controls engine idle speed.

(b) It limits the maximum no-load engine speed.

(9) The fuel injectors that are used in the Detroit 8V92TA engine that powers the MK48 are needle valve type injectors. There is, of course, one injector for each cylinder and they are mounted in the cylinder heads.

(a) The injectors pressurize, meter, atomize, and inject the fuel required for engine operation.

(b) The timing of injection is controlled by a camshaft that activates the injector push rods and rocker arms in the conventional manner. Movement of the rocker arms forces the injector plungers down which forces fuel to be injected.

(c) The amount of fuel that is injected is determined by the opening and closing of ports in the injector body. The same plungers that are actuated by the rocker arms are also rotated by a rack gear. This rotation varies the alignment of the ports previously mentioned to determine the amount of fuel delivery. Bear in mind that all injector rack gears are connected by way of the injector control tube assemblies; therefore, the effects of the governor and the position of the throttle treadle valve affect fuel delivery to all cylinders equally.

(10) As was previously covered in your instruction on the engine, the throttle control cylinder is an air actuated cylinder that is attached to the top, right front side of the engine.

(a) The MK48 does not have a straight mechanical linkage or a cable system between the throttle treadle valve and the speed control lever on the governor to allow the operator to control engine speed. A combination of air pressure and linkage is used.

(b) When the driver pushes down on the throttle treadle valve, air pressure, in direct relation to the movement of the treadle valve, is applied to the throttle cylinder. The air pressure extends a rod that is attached to the throttle lever which rotates the governor speed control shaft and the engine's speed is increased to the desired rpm. When the operator releases the treadle valve, a spring inside the throttle cylinder, assisted by an external spring, retracts the linkage and returns the engine to idle speed.

(11) The throttle treadle valve is used to supply air pressure to the throttle control cylinder which regulates the position of the throttle lever. The throttle treadle valve is located in the cab of the vehicle and is to the right of the brake pedal.

(12) The shutdown solenoid is an electrically controlled unit used to shut down or stop the engine. The shutdown solenoid is mounted at the top front of the engine and is attached to the stop lever on the governor.

(a) The shutdown solenoid is controlled by a switch in the vehicle cab. When the engine stop switch is pushed down, the solenoid pulls the stop lever on the governor inward. That action moves a series of rods in the engine and shuts off fuel flow to the injectors.

(b) In the event that an electrical failure renders the shutdown solenoid inoperative, the engine can be shut down by manually pushing the rod on the shutdown solenoid toward the solenoid.

(13) The ether starting aid is a system that permits the injection of ether into the engine to aid in cold weather starts. The system consists of a fuel bottle, solenoid valve, switch, atomizer, and thermostat, commonly called a sending unit. By pressing the ether start switch, the solenoid valve is energized to the open position. Ether will then travel from the fuel bottle through tubing to the atomizer located in the air inlet housing. The atomizer mixes the ether with the incoming air. Releasing the ether start switch will disengage the solenoid valve, closing off the fuel bottle. The sending unit, located at the left rear of the engine, just above the starter, prevents the system from operating when the engine temperature is 70 degrees Fahrenheit or above.

2. PRINCIPLES OF OPERATION OF THE DETROIT 8V92TA DIESEL ENGINE FUEL SYSTEM

a. The fuel pump, located at the right front of the engine, receives diesel fuel from the tanks, through the fuel/water separator and a one-way check valve. The fuel pump increases the fuel pressure to approximately 60 psi. After leaving the fuel pump, the diesel fuel goes through the secondary fuel filter. From the secondary filter, it goes to each cylinder head, by way of two separate fuel lines.

b. Fuel is then directed into the inlet manifold of each cylinder head. Fuel goes through the manifold and out to the injector inlet by way of fuel connector pipes. Fuel then flows through the injector where a certain amount, depending upon the engine load, is metered to run the engine. The amount of fuel is mechanically determined by way of the injector control tubes and the limiting speed governor.

c. The remaining fuel circulates through the injector to help cool it. Fuel leaves the injector through the return fuel connector pipe and travels to the return manifold cast inside the cylinder head. Fuel flows out of the cylinder heads to a restricted tee. This restricted tee maintains manifold pressure within the cylinder heads. From the tee, fuel flows through a single fuel line back to the right fuel tank.

d. To perform the fuel flow test, use the following procedures:

(1) First, close the shut off valve on the balance line at the left fuel tank.

(2) Next, the fuel return line must be removed from the return elbow below the fuel filter on the right hand fuel tank. Before you remove the line, have a plug to insert in the elbow. Remove the fuel line and then plug the elbow.

(3) Position the return fuel line in a calibrated fuel container. The container must be capable of holding 2 gallons. Have an assistant start the engine and run it at 1800 rpm for one minute only. After exactly one minute, have the assistant shut down the engine.

(4) Check the amount of fuel in the container. There should be 1.4 gallons of fuel delivered during that one minute period. If the fuel flow is below this specification, perform the following procedures:

(a) First, check the fuel lines for kinks or damage. If the fuel lines have no damage or kinks, the spin-on fuel filter must be replaced. The replacement of the filter will be covered in another lesson. After the filter has been replaced, recheck the fuel flow following the procedures that were previously stated.

(b) If the fuel flow is still below specification, the fuel pump must be replaced with a pump that is known to be serviceable. This replacement procedure will be covered in a future lesson. After the fuel pump has been replaced, recheck the fuel flow. If the fuel flow is still below specification, then your supervisor must be notified.

(5) After the fuel flow test has been performed, unplug the elbow and reinstall the fuel line back onto the return elbow at the bottom of the right fuel tank. Tighten the line securely. Now open the shutoff valve on the left fuel tank.

3. ORGANIZATIONAL MAINTENANCE RESPONSIBILITIES FOR THE DETROIT 8V92TA DIESEL ENGINE FUEL SYSTEM

a. The organizational mechanic is responsible for replacing the fuel tanks and all the components of the fuel system from the tanks to the injectors, with exception of the governor. Replacement of the governor and injectors is third echelon maintenance responsibility.

b. The organizational mechanic is responsible for the repair of the fuel supply pump, the throttle control cylinder, and the fuel/water separator. The organizational level mechanic is also responsible for adjusting the shutdown solenoid, and servicing the fuel/water separator.

4. REPAIR AND/OR INSPECTION OF THE FUEL SUPPLY SYSTEM COMPONENTS EMPLOYED IN THE DETROIT 8V92TA ENGINE FUEL SYSTEM

a. Repair The Engine Fuel Supply Pump

(1) Inspect the fuel supply pump. Check for fuel leaking out of the drain hole in the pump body. If the leakage exceeds one drop per minute, the fuel pump must be disassembled and the seals replaced.

(2) Removal of the fuel supply pump. The procedures are as follows:

(a) First, the vehicle batteries must be disconnected.

(b) Before you can remove the pump, you must gain access to it. This can be accomplished by removing the engine access panels from inside the cab. Then you must loosen the four hose clamps on the bypass tube. Do not attempt to remove the tube. You will only need to rotate the tube in order to gain proper access.

(c) Next, remove the front engine lifting bracket bottom bolt and rotate the lifting bracket up.

(d) Now that you are able to get to the fuel pump, the next step is to tag and remove the two fuel lines.

(e) Disconnect the shutdown solenoid at the bracket clip and remove the three mounting capscrews securing the solenoid to the mounting bracket. Swing the solenoid out of the way.

(f) Remove the mounting capscrews and the fuel pump assembly from the governor housing.

CAUTION: The drive fork is loosely mounted on the drive shaft and may fall off when you are pulling the pump away from its mounting.

(g) Now that the pump has been removed, you can remove and discard the gasket. Also the two fuel line elbows, coupling, and nipple must be tagged and removed.

(3) Repair the fuel supply pump. The first procedure involves disassembling the fuel pump. The procedures are as follows:

(a) Begin by mounting the fuel pump holding fixture into a soft-jawed vise and then place the fuel pump onto the holding fixture.

(b) Once the fuel pump is securely mounted, remove the cover capscrews and the cover from the body.

(c) Pull the drive shaft from the pump body. The drive shaft is the long shaft. After the shaft is removed, visually inspect the shaft for scoring or wear. If the gear feels loose on the shaft, the shaft and gear must be disassembled. To disassemble the drive shaft the following procedures are used:

1 Place the drive shaft in a press so that the square end of the shaft is towards the press bed.

2 Now, carefully press the gear down towards the square end of the shaft. The gear must not be pressed through the square end of the shaft. Continue to press the gear until the retaining ball can be removed.

CAUTION: The retaining ball is very small and can easily be lost.

3 After you have removed the retaining ball, turn the drive shaft over and press the gear off the shaft.

(d) The next step is to remove the driven gear and shaft assembly from the pump. Inspect this shaft for wear or scoring. Also check

the gear for nicks, burrs, or wear. If the shaft assembly is found to be unserviceable, the gear and shaft must be replaced as an assembly. Do not attempt to disassemble it.

(e) If it was determined that the seals were leaking during the initial inspection, then they must be replaced. You should inspect the seals even if they were not leaking. To remove the seals, install the pump body into a soft-jawed vise. Using a hammer and a drift pin, remove the seals from the pump body and discard them.

(f) The last part to remove is the relief valve assembly. You should always remove this assembly, even if you were only replacing the seals. To remove the relief valve, remove the plug and gasket. Then pull the spring pin and valve from the pump body. After they have been removed, inspect the components for nicks, burrs, or signs of wear. These parts should be inspected very closely.

(g) At this point, you should have the fuel pump completely disassembled. We will now start to assemble the fuel pump. First, we have to coat the lips of the seals with a little grease.

(h) The placement of the seals is very important. If the seals are not installed properly, they will end up leaking.

1 First, place the inner oil seal on the seal installer so that the inner seal lip faces towards the pump body.

2 Support the pump body on a couple of wooden blocks and insert the seal installer into the body. Drive the seal into the body until it is seated.

3 Next, install the adapter onto the seal installer so that the short end is away from the handle.

4 Now, place the outer oil seal on the installer so that the seal lip faces towards the installer adapter. Insert the seal into the body and drive the seal in until the adapter makes contact with the pump body.

(i) Next, clamp the pump body into a soft-jawed vise so the relief valve port is facing up. Lubricate the relief valve with some clean engine oil and insert it into the body so the valve's hollow end is up.

(j) Now, insert the pin and spring into the valve. Install the plug and gasket to lock the relief valve in the pump body. Torque the plug to the specifications that are given in your technical manual.

(k) If the drive gear was removed from the shaft, the following procedures must be accomplished to assemble it.

1 Place the drive gear on the round end of the shaft. The slot in the gear must be towards the round end.

2 Press the gear beyond the ball notch on the shaft. Place the retaining ball into the notch and then press the gear back until the end of the slot contacts the ball.

(l) Lubricate the shaft assembly with engine oil and install the square end of the shaft into the pump body.

(m) Lubricate the gears and shafts with clean engine oil.

(n) Now, apply a thin coat of adhesive sealant to the mating surface of the cover. Make sure no sealant is applied to the contact area of the gears. Install the cover on the body, alternately tighten the capscrews to ensure an even fit.

(o) After the pump has been assembled, rotate the drive shaft by hand. If the shaft does not rotate freely, attempt to free it by tapping on the corner of the pump. If the pump still sticks, you have to disassemble the pump and recheck all the parts.

(4) Installation of the fuel supply pump. The installation procedures can be accomplished in the reverse order of removal. One point you should remember when installing the fuel pump is to make sure the drain hole is facing down, towards the engine.

b. Repair Detroit 8V92TA Engine Hand Priming Pump

(1) Check the function of the hand priming pump.

(a) First remove the hand priming pump outlet line at the fuel/water separator. Place the fuel line in a suitable container and plug the outlet elbow.

(b) Next, push in the priming pump knob and turn it counterclockwise to release it. Push and pull the knob about three times and check for fuel output into the container. If little or no fuel is pumped into the container, the hand priming pump must be replaced.

(c) Once you have determined the serviceability of the hand priming pump, install the fuel line back on the fuel/water separator and lock the knob on the priming pump by pushing it in and turning it clockwise.

(2) Removal of the hand priming pump. Use the following procedures to remove the hand priming pump.

(a) First, loosen the handle locknut. Then place a drain pan below the handle assembly and pull the handle from the barrel.

(b) Next, remove the outside barrel locking nut, push the barrel through and away from the mounting bracket.

(c) The last step is to tag and remove the fuel lines and elbows from the barrel. Also, remove the washer and the inside locking nut.

(3) Installation of the hand priming pump. The installation of the hand priming pump is accomplished in the reverse order of removal. After the hand pump is installed, you should check the operation of the pump.

c. Repair of the Fuel Tank Assembly

(1) Inspection of the fuel tanks.

(a) First, look for any signs of leaks or obvious damage.

(b) While you are looking for leaks, check for any excessive dents in the tanks. These dents will normally be found on top of the tanks.

(c) The last items to check for are loose mounting straps, fuel line connections, and drain plug. Also inspect these components for damaged threads.

(2) Inspection of the fuel lines. Inspect the fuel lines for cuts, cracks, bends, and kinks. Also check the elbows and fittings for damaged threads, signs of leakage, and excessive wear.

(3) Inspection of the fuel tank vents. Inspect for a missing, damaged, broken, or clogged vent line. Also inspect the vent elbow for damaged connections.

d. Repair of the Shutdown Solenoid

(1) Test the shutdown solenoid. When you test the shutdown solenoid, two malfunctions could occur. First, the shutdown lever moves but will not shut down the engine. Second, the shutdown solenoid lever will not move. We will first cover the testing procedures for a malfunction wherein the shutdown lever does not move.

(a) First, remove the engine access panel inside the cab. Once you have the panel removed, depress the engine stop switch and check for movement of the governor stop lever. You can normally hear the lever click when it is working properly. If the lever does not move, the electrical circuit of the shutdown solenoid must be checked out.

1 First check for 24 volts at the batteries. If 24 volts are not present, determine the cause and correct the problem.

2 If 24 volts are present at the batteries, check for 24 volts on wire 019 terminal of the shutdown solenoid with the engine stop switch held down.

a If 24 volts are present, check for a poor connection at the ground wire or at the wire terminals. If the connections are good, then replace the shutdown solenoid.

b If 24 volts are not present, check for voltage at the stop switch.

3 With the stop switch held down, check for 24 volts on wire 019 terminal at the stop switch.

a If 24 volts are present, repair or replace the wire between the engine stop switch and the shutdown solenoid.

b If 24 volts are not present, check for 24 volts at wire 096 terminal on the stop switch. If 24 volts are present, replace the stop switch. If 24 volts are not present at wire 096 terminal, then check the circuit breaker.

4 Check for 24 volts at wire 096 terminal of circuit breaker No. 5.

a If 24 volts are present, repair or replace wire 096 from the circuit breaker to the stop switch.

b If 24 volts are not present, check for 24 volts on wire 430 terminal of the circuit breaker. If voltage is present at wire 430 terminal, replace the circuit breaker. If 24 volts are not present at wire 430 terminal, the main electrical system must be checked.

(b) The second malfunction to isolate is when the shutdown lever moves but the engine does not shut down.

1 Before you start the engine, depress the engine stop switch and make sure that it moves.

2 If the lever moves, start the engine and depress the stop switch. If the engine stops, the shutdown solenoid is working properly. If the engine does not stop running, the shutdown solenoid must be adjusted.

(2) Adjust the shutdown solenoid.

(a) If the shutdown solenoid has to be adjusted, the first step is to loosen both locking nuts on the shutdown solenoid shaft. Loosen the locknut that is on the solenoid side all the way towards the solenoid.

(b) Then have an assistant hold the governor stop lever in the no-fuel position or towards the solenoid. If the engine had been running, it should stop at this time. If the engine does not stop running, notify your supervisor.

(c) Now, push the shutdown solenoid shaft in all the way and hold. Tighten the locknut that is closest to the governor, until it is snug against the solenoid bracket. Tighten the other locknut against the bracket.

(d) After making the adjustment, you should then check for proper operation.

e. Repair of the Throttle Control Cylinder

(1) Inspection of the throttle control cylinder.

(a) Before you start checking the cylinder, make sure the air system is fully charged. Now start the vehicle and check for any leaks around the air lines and rear cover of the cylinder.

(b) While the engine is running, check for proper operation of the control cylinder. Pay particular attention to the linkage and rod end assembly for free movement.

(c) Now, shut down the engine and inspect the dust boot for tears or holes.

(d) Also, inspect the spring for damage, rust, or for being stretched.

(2) Removal of the throttle control cylinder. We will now remove the throttle control cylinder by using the following procedures:

(a) First, apply the parking brakes and drain the complete air system.

(b) Next, climb into the cab and remove the access panel. After the access panel is removed, tag and remove the air lines at the control cylinder.

(c) Put a scribe mark across the throttle lever and the governor shaft. This will ensure correct alinment during installation.

(d) Now, the control cylinder is ready to be removed from the governor. Remove the mounting capscrews and lift the cylinder, throttle lever, and spring off the governor as an assembly.

(e) Remove the throttle lever, spring, bracket, check valve and adapter from the throttle control cylinder.

(3) Repair of the throttle control cylinder. The following procedures will be used to repair the throttle control cylinder:

(a) First, remove the rear cover from the cylinder.

(b) To remove the rod end assembly, install an Allen wrench into the piston and a wrench on the flat part of the rod assembly. The Allen wrench will prevent the piston from turning while you are removing the rod end assembly.

(c) Remove the rod end assembly and push the piston out of the cylinder. Discard the rod end assembly.

(d) After the piston has been removed, the next step is to remove the spring, U-cup, wear ring, shell and O-ring from their components.

(e) The last step is to remove the dust boot and alinement spacer. The dust boot must be discarded.

(f) First, install a new shell into the cylinder, then lightly coat the new O-ring with silicone lubricant and carefully push it into position around the shell.

(g) Next, thoroughly coat the new wear ring and U-cup with silicone lubricant. Now install them onto the piston. Make sure the open end of the U-cup faces away from the wear ring.

(h) After the piston has been assembled, place the spring on the piston and install the assembly into the cylinder.

(i) Then, install the alinement spacer onto the new dust boot so the small end of the spacer is facing toward the cylinder. Install the dust boot and spacer onto the cylinder.

(j) The last steps are to install a new rod end assembly and the rear cover. You must apply adhesive to the threads on the piston. The type of adhesive and the torque specifications can be found in the technical manual.

(4) Installation of the throttle control cylinder. The procedure for installing the throttle control cylinder can be accomplished by reversing the order of removal. One important point to remember when installing the control cylinder is to make sure the scribe marks aline on the throttle lever and the governor shaft.

f. Repair of the Fuel/Water Separator

(1) Inspection of the fuel/water separator.

(a) Begin by inspecting for any obvious leaks around the fuel bowl, fuel lines, and sealing surfaces.

(b) Next, inspect the housing and lid for dents, cracks, or improper sealing of the mating surface.

(c) Now, move down to the fuel bowl and check the terminal for looseness or broken wires.

(d) While you are at the fuel bowl, check to see if there is a build up of contaminants at the very bottom of the bowl. If there are two different colors of fluid, this is a good indication that there is water in the diesel fuel. If either condition is present, the fuel/water separator must be serviced.

(2) Service the fuel/water separator. To service the fuel/water separator, you must proceed as follows:

(a) First, remove the lid by turning the tee handle counterclockwise. This will allow the fuel to drain quicker when the drain cock is opened.

(b) Next, drain the fuel from the fuel/water separator.

1 To drain the fuel, remove the fuel line from on top of the right fuel tank.

2 Now, attach a hose to the drain at the bottom of the separator. Place the other end of the hose in a container that is capable of holding at least two gallons.

3 After the drain hose is installed, turn the drain cock and let all the fuel drain out of the fuel/water separator.

(c) Once the bowl is completely drained of fuel, remove the drain hose and close the drain cock.

(d) Now, you can remove the filter from the top of the separator. You may have to turn it while you are pulling it from the housing. Dispose of the filter. Do not reuse the filter or the drained fuel.

(e) Next, remove the drain cock from the bowl. Place the container under the bowl and pour clean diesel fuel through the separator housing. This will clean any loose particles that happen to remain. If there is still excessive build-up of sludge in the fuel bowl, the bowl will have to be removed.

1 To remove the bowl, you first need to remove the four screws and retainer holding the bowl and tag the two wires.

2 Next, lower the bowl just enough to remove the wires.

3 Now, remove the bowl and gasket and clean the bowl thoroughly with clean diesel fuel. Also, wipe out the separator housing if any large deposits of sludge can be seen.

4 Once the bowl is cleaned, a new gasket should be coated with clean diesel fuel and installed into the base of the separator.

5 Connect the two wires to their terminals and position the bowl with the retainer and four capscrews.

(f) After thoroughly cleaning the separator, the next step is to install the drain cock back into the bowl. Next, install a new filter element and fill the separator with clean diesel fuel.

(g) Next, install the lid and tighten it down with the tee handle. Last, install the fuel line onto the right fuel tank and finish priming the system with the hand priming pump.

(3) Removal of the fuel/water separator. Before removing the fuel/water separator, drain the separator. Then tag and remove all the fuel

lines and wires that are connected to the separator. Also plug all the fuel lines to prevent fuel from draining.

(a) Now, have an assistant hold the separator while you remove the mounting capscrews and nuts and lift the separator off the bracket.

(b) Once you have the fuel/water separator removed from the bracket, remove the attaching elbows, reducers, adapters and nipples. You should tag or note the configuration of the plumbing before you remove it.

(4) Repair the fuel/water separator. During the servicing of the fuel/water separator we covered most of the steps involved in disassembling the separator. Therefore, we will not cover those again. We will pick up at the point where the fuel bowl has been removed.

(a) After the fuel bowl is removed, pull the heater disc up through the top. Carefully guide the wires through the baffle and base.

(b) Then remove the turbine, baffle, check ball, and the check ball gasket. Discard the check ball gasket.

(c) Reassembly of the fuel/water separator can be accomplished by reversing the disassembly and servicing procedures.

(5) Installation of the fuel/water separator. When installing the fuel/water separator, coat all the threads of the fuel fittings and connections with pipe sealant.

(a) To install the fuel/water separator, you first have to install the elbow, nipples, bushings, and reducers back into their tagged location.

(b) Next, install the fuel/water separator into the bracket and install the assembly onto the vehicle.

(c) Now, install all the fuel lines and wires in their tagged location. Remember to apply pipe sealant to all threads.

(d) The last step is to prime the fuel system and check for any sign of leaks.

g. Inspection of the Engine Ether Starting Aid

(1) We will begin by inspecting the canister cylinder for loose mounting.

(2) If you suspect the canister of being low on charge, remove it from the vehicle and weigh it. A full cylinder should weigh about thirty-seven ounces and an empty cylinder weighs about seventeen ounces.

(3) Next, check the electrical connections for looseness and wires for frays, exposure, or pinched condition.

(4) Now, move to the ether line and inspect it for holes, kinks, or loose connections.

(5) After following the ether line, you should end up at the atomizer. Check the atomizer for looseness or damage.

h. Testing of the Ether Start System

(1) The ether start switch is located at the right side of the instrument panel. The ether start sending unit is located on the left rear of the engine just above the starter motor. The sending unit will not become activated until the engine coolant temperature is 70 degrees Fahrenheit or lower.

(2) To test the ether start sending unit, the ignition switch must be in the ON position and the multimeter conditioned to read 24 volts.

(a) First, disconnect wire number 036 at the ether solenoid.

(b) Next, place the black lead to ground and the read lead to wire number 036, and check or 24 volts while the ether switch is ON.

(c) If 24 volts are present, condition the multimeter to read ohms, and check for continuity between pin one of wire number 036 at the ether start solenoid harness plug and wire number 036 at the sending unit. If 24 volts are not present, condition the multimeter to read 24 volts and move the red lead to the input terminal of the ether start switch wire number 036 and check for 24 volts.

(d) If 24 volts are present, replace the ether start switch.

(e) If continuity between pin one of wire number 036 at the ether start solenoid harness plug and wire number 036 at the sending unit is found, check the ether temperature sending unit for continuity.

(f) With the multimeter conditioned to read ohms, the reading should be 0 ohms below 70 degrees F $\pm$ 10 degrees.

(g) If the reading is not 0 ohms, replace the sending unit. If the reading is 0 ohms, check for 0 ohms reading between the ground and ground wire number 036 at the sending unit.

(h) If the reading is 0 ohms, replace the solenoid. If the reading is not 0 ohms, repair or replace wire number 036.

(i) If continuity between pin one of wire number 036 at the ether start solenoid harness plug and wire 036 at the sending unit is not found, check for continuity between pin one on wire number 036 at the ether start solenoid harness plug and pin one at the plug connector from the main harness.

(j) If continuity is found, replace wire number 036 from the sending unit to the plug connector.

(k) If continuity is not found, replace wire number 036 from the plug connector to the connector at the ether start solenoid.

(3) To test the ether start switch, condition the multimeter to read 24 volts.

(a) First, place the black lead to ground and the red lead to wire number 036 on the output terminal of the switch.

(b) Turn the ether switch on and check for 24 volts. If 24 volts are present, repair or replace wire number 036 between the switch and plug at the solenoid. If 24 volts are not present, check for 24 volts on the input terminal of ether switch wire number 036.

(c) Move the red lead to wire number 036 at the input terminal of the ether switch, and check for 24 volts. If 24 volts are present, replace the switch. If 24 volts are not present, check for 24 volts on wire number 036 at circuit breaker No. 11.

(d) Move the red lead to wire number 036 at circuit breaker No. 11 and check for 24 volts. If 24 volts are present, repair or replace wire number 036 between the switch and circuit beaker. If 24 volts are not present, then check for 24 volts on wire number 640 at the input terminal of circuit breaker No. 11.

(e) Move the red lead to wire number 640 at the input terminal of circuit breaker No. 11. If 24 volts are present, replace the circuit breaker. If 24 volts are not present, then check for 24 volts on wire number 640 at the ignition switch.

(f) Move the red lead to wire number 640 at the ignition switch, and check for 24 volts. If 24 volts are present, repair or replace wire number 640 between the ignition switch and the circuit breaker. If 24 volts are not present, then check for 24 volts on wire number 431 at the ignition switch.

(g) Move the red lead wire to number 431 at the ignition switch. If 24 volts are present, replace the ignition switch. If 24 volts are not present, then check for 24 volts on wire number 431 on the input side of circuit breaker No. 5.

(h) Move the red lead to wire number 431 on the input side of circuit breaker NO. 5. If 24 volts are present, repair or replace wire number 431 from the circuit breaker No. 5 to the ignition switch. If 24 volts are not present, you must troubleshoot the electrical system. Refer to your technical manual for complete troubleshooting procedures.

i. Inspection of the Throttle Treadle Valve

(1) First, make sure the air pressure in the system is up to normal operating capacity. Then check for leaks around the air line connections at the treadle valve and also the lines going to the throttle control cylinder.

(2) Next, inspect the throttle treadle valve housing for cracks or loose mounting capscrews and listen for leaking air.

5. DIAGNOSE MALFUNCTIONS IN THE DETROIT 8V92TA ENGINE FUEL SYSTEM

a. General

(1) The transparency that you see on the screen lists the fuel system malfunctions that are covered in the troubleshooting section of the TM.

(2) To quickly find the troubleshooting procedure you need, use the Symptom Index. Symptoms are listed by components or systems.

(3) Each malfunction symptom given for an individual component or system is followed by steps leading to the cause of the malfunction and the actions required to correct it.

(4) Locate the malfunction symptom then thoroughly read and carefully follow each step of the troubleshooting procedures.

(5) Here are a few simple rules to follow when troubleshooting:

(a) Obtain as much information from the operator as possible about the malfunction.

(b) Never overlook the possibility that the problem may be a simple one and may be repairable with a simple adjustment.

(c) Use as many of your senses as you can to locate and isolate problems. Look at it, listen to it, smell it, and feel it.

(d) Use all available test equipment to help find and isolate problems.

(e) Whenever possible, isolate the system first and then the component causing the malfunction.

(f) Remember, there is a cause for every failed part. Whenever possible, determine the cause of the failure before assuming the malfunction is completely repaired.

(g) Use proven automotive theories and principles when troubleshooting the vehicle.

b. Malfunction No. 1 (Engine will not start or stalls)

c. Malfunction No. 2 (Engine does not start when the ether starting aid is used in cold weather.)

REFERENCE:

TM 2320-20/12